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The Shareholder Wealth Effects of Insurance Securitization: Preliminary Evidence from the Catastrophe Bond Market*

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Abstract

Insurance securitization has long been hailed as an important tool to increase the underwriting capacity for companies exposed to catastrophe-related risks. However, global volumes of insurance securitization have remained surprisingly low to date which raises questions over its benefits. In this paper, we examine changes in the market value of insurance and reinsurance firms which announce their engagement in insurance securitization by issuing catastrophe (Cat) bonds. Consistent with the hitherto underwhelming contribution of Cat bonds to global catastrophe coverage, we do not find evidence that Cat bonds lead to strong wealth gains for shareholders in the issuing firm. More importantly, we report large variations in the distribution of wealth effects in response to the issue announcement. We show that the wealth effects for shareholders in firms which issue Cat bonds appear to be driven by explanations according to which Cat bonds offer cost savings relative to other forms of catastrophe risk management (and less by the potential of Cat bonds to hedge catastrophe risk). Thus, abnormal returns are particularly large for issues by firms which face low levels of loss uncertainty (which reduces the information acquisition costs in financial markets) as well as for issues during periods when prices for catastrophe coverage (including Cat bonds) are low.

JEL codes: G20, G22, G32
Keywords: Insurance securitization, Catastrophe risk, Catastrophe bonds, Performance

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1. Introduction

Insurance and reinsurance firms have experienced a remarkable increase in underwriting losses from natural catastrophes over the past decade. Catastrophes such as Hurricane Katrina in 2005 and the recent earthquake and tsunami in Japan pose great risks to these firms, because the underwriting losses linked to catastrophe events are usually large relative to capital reserves (Froot, 2001; Froot and O'Connell, 2008). As a result, the total volume of global risk-financing capacity of catastrophes has remained limited to date. This leaves open the prospect of insolvencies and instability in global insurance and reinsurance markets in the event of a severe natural catastrophe (Cummins et al., 2002; Cummins and Trainar, 2009).

Catastrophe (Cat) bonds have long been hailed as securitization vehicles that can markedly increase global risk financing capacity by transferring catastrophe risks to capital markets (e.g. Jaffee and Russell, 1997; Froot, 2001). Cat bonds are insurance derivatives whose payoffs depend on the occurrence of a catastrophe loss event. When the catastrophe loss event occurs, the issuing firm may forfeit on principal and/or coupon payments. While the market for Cat bonds has undergone rapid growth in response to a general increase in the amount of catastrophe-related underwriting losses, the overall volume of insurance securitization has remained underwhelming to date.[*] This has led some commentators to argue that the benefits of Cat bonds for the issuing firm are limited (Lakdawalla and Zanjani, 2006).

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[*] The volume of Cat bonds has grown rapidly following the particularly disastrous U.S. hurricane season of 2005 ('Catastrophe-Bond Supply Builds Up', *The Wall Street Journal,* 27 September 2006). Increasingly, Cat bonds are also attracting the attention of retail investors ('Catastrophe Bonds: Ports and Storms', *The Economist,* 2 August 2007) as well as of governments in developing countries seeking affordable ways of financing reconstruction in the aftermath of natural catastrophes ('Catastrophe insurance: When Calamity Strikes', *The Economist,* 21 January 2010).

Given the potential importance of Cat bonds to insurance and reinsurance markets, uncertainty over whether and how firms with catastrophe-related underwriting exposure benefit from securitizing the resulting risks is an important issue. In this paper, we empirically address this issue by analyzing the performance effects of Cat bonds on the issuing firm. For a unique sample which consists of the near population of Cat bond issues by listed companies up to May 2010, we compute changes in the market value realized by firms which announce their intention to issue a Cat bond.

This paper makes two important contributions. First, we present the first empirical investigation into the wealth benefits of Cat bonds. Given the relatively low number of Cat bond issues to date, previous work on Cat bonds has been mostly theoretical (e.g. Bantwal and Kunreuther, 2000; Lakdawalla and Zanjani, 2006) with empirical work lagging behind. This has led to considerable uncertainty as to the actual effects of Cat bonds on the issuing firm. While the low number of Cat bond issues to date also means that our results have to be interpreted with suitable care, we are the first to show that, even though Cat bonds do not lead to strong wealth gains for shareholders in the issuing firm, there are large variations in the market revaluation effects linked to Cat bonds.

Second, our study helps to understand the motivations for why firms issue Cat bonds. While the motivations for banks to engage in asset securitization have previously been analyzed (e.g. Ambrose et al., 2005; Lockwood et al., 1996, Martin-Oliver and Saurina, 2007), much less is empirically known about the reasons why firms engage in insurance securitization. Jointly, our results support the notion that firms issue Cat bonds less as a means to hedge catastrophe risks and more as a means to realize cost efficiencies relative to other forms of catastrophe risk management. For instance, we find that the value effects linked to Cat bond issues are particularly pronounced for firms with less volatile losses from their insurance business. We argue that this group of firms is likely to benefit from lower information acquisition costs in financial markets when they substitute reinsurance coverage using Cat bonds (see Gibson, Habib and Ziegler 2011). In the same vein, since Cat bond prices are fixed over a multi-year period and remain unaffected by future price increases in the market for catastrophe coverage, we find that issuer abnormal returns are particularly high during periods of low catastrophe reinsurance prices when the costs of raising capital via Cat bonds are relatively low.

The remainder of the paper is organized as follows. Section 2 surveys the previous literature on why firms may benefit from issuing Cat bonds and develops the propositions to be tested in the paper. Section 3 discusses the data and empirical strategy. Sections 4 and 5 then present the results of the univariate and multivariate analysis, respectively. Finally, Section 6 concludes and discusses the implications of the findings.

2. Theory and Literature: Do Companies Benefit from Issuing Cat bonds?

Most of the reasons for why firms may benefit from issuing Cat bonds can be summarized into two main arguments. First, Cat bonds allow firms to hedge against catastrophe-related underwriting losses. Second, Cat bonds can help firms with catastrophe exposure to realize costs savings on catastrophe-related risk management.

The first argument is that Cat bonds allow the issuer to hedge against catastrophe-related underwriting losses by transferring catastrophe risks to capital markets (e.g. Niehaus, 2002; Harrington and Niehaus, 2003; Cummins et al., 2004). The argument is based on the rationale that Cat bonds typically let the issuing firm forfeit on principal and/or coupon payments subject to a catastrophe event occurring. Cat bonds can, therefore, be viewed as a form of subordinated debt which, once forgiven, free up funds to absorb underwriting losses caused by a specified catastrophe.

In practice, however, the payoff structure of Cat bonds rarely makes them a perfect hedge against underwriting losses. This is because the triggers, which permit forfeiture, do not necessarily match the specific loss experience of the issuer. Instead, triggers tend to be defined in terms of industry losses (e.g. via loss indices). While index-based triggers are meant to keep issuers from transferring their highest portfolio risks to unsuspecting investors (Doherty, 1997), any mismatch between the payoffs from issuing Cat bonds and the losses experienced by the issuer in a catastrophe event gives rise to so-called basis risk. Simulation analyses conducted by Harrington and Niehaus (1999) and Cummins et al. (2004) show that the basis risk linked to index-based triggers is manageable for U.S. homeowner insurers and large Hurricane insurers in Florida, respectively. Nonetheless, it is important to bear in mind that these results are based on simulations. The risk that the payoffs from index-based Cat bonds do not cover the issuer's catastrophe losses remains a valid concern for issuing firms. However, regarding basis risk and Cat bonds, it is also important to bear in mind that the payoffs in a classical insurance setup may also be inefficient. Some insurance and reinsurance contracts include a cap on the losses which may be indemnified, which means that insurance coverage may not fully indemnify an insurer's losses either in the event of a natural catastrophe.

While the presence of basis risk diminishes the effectiveness of Cat bonds as a perfect hedge, there are also questions over the extent to which Cat bonds help diversify catastrophe exposures more generally. Commonly, insurers economize on capital and realize diversification gains by protecting insured value in excess of the capital held against it. However, in contrast to insurance agreements, Cat bonds frequently offer full collateralization of risk exposures. This is because the funds reserved for principal payment are placed in special trusts and cannot be used to offset losses caused by events other than the trigger event (Niehaus, 2002; Lakdawalla and Zanjani, 2006). In that respect, it could be argued that capital provision via Cat bonds is inefficient, because it precludes the type of capital diversification benefits linked to traditional insurance and reinsurance.

The second argument for why firms could benefit from issuing Cat bonds is based on issuing firms realizing costs savings on catastrophe-related risk management. Traditionally, catastrophe risk management for underwriting firms involves either raising capital (to absorb losses) or purchasing reinsurance (to seek indemnity from all or part of the losses caused by a catastrophe event). The cost of purchasing reinsurance coverage for catastrophe risks is expensive since reinsurance premiums are high relative to actuarial loss estimates (see Lane and Mahul, 2008). This is why especially higher layers of protection (i.e. protection against events with a very low probability of occurrence) often go unreinsured by insurers (Froot, 2001). Therefore, insurers that seek to increase their catastrophe underwriting capacity will typically have to rely on raising capital. However, raising capital to absorb catastrophe losses is costly for both insurance and reinsurance companies (e.g. Jaffee and Russell, 1997; Froot, 2001; Niehaus, 2002). For insurance companies, raising equity capital is costly because it is tax-inefficient, while raising debt capital to finance catastrophe risks increases the probability of financial distress of the insurer (Niehaus, 2002). For reinsurance companies, raising capital to increase their capacity to underwrite catastrophe risks is costly, as it is likely to lead to higher costs of capital. This is because catastrophes are large correlated loss events which reinsurers cannot fully diversify (Froot and Stein, 1998; Froot and O'Connell, 2008).

Against this background, Cat bonds could provide a cost-efficient substitute for risk management via reinsurance. Froot and O’Connell (2008) argue that because catastrophe risks are both quantifiable and diversifiable for investors, the required rate of return from holding Cat bonds should equal the risk-free rate. This argument stands in contrast to the findings of applied work which shows that, while spreads on Cat bonds have fallen in recent years, they remain well above risk-free levels (Lane and Mahul, 2008) and are comparable to reinsurance premiums for catastrophe coverage (Cummins et al., 2004).[*] However, comparing the pricing of Cat bonds with reinsurance premiums is unlikely to convey an accurate picture of the net costs and benefits linked to insurance securitization as compared with reinsurance coverage. Among other things, such comparisons do not take into account that Cat bonds (vis-à-vis reinsurance contracts) carry lower counterparty risk (Cat bond principals are fully collateralized), provide liquidity benefits for the issuer (Cat bond premiums are paid at the end of each quarter rather than upfront as in the case of reinsurance) and result in more predictable cost management for the issuer (Cat bonds fix the costs of coverage at the time of issue for a multiyear period).

Nonetheless, there remain good reasons to argue that some issuers should realize cost savings from issuing Cat bonds compared with obtaining reinsurance. Gibson, Habib and Ziegler (2011) compare the information-gathering incentives of traders in financial markets (Cat bonds) with the incentives of reinsurers and develop a model where it is relatively more cost efficient for insurers which face low levels of loss uncertainty to securitize catastrophe risks. They argue that lower levels of loss uncertainty reduce the information acquisition costs in financial markets (which are ultimately borne by the issuer via a discount on the price of the securities issued[†]). Therefore, insurance securitization may be a less costly alternative to either reinsurance or to raising equity for insurers facing low levels of loss uncertainty.

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[*] One frequently advanced explanation for the high spreads on Cat bonds is that investors are still unfamiliar with the concept of insurance securitization and, therefore, demand a return premium (see Bantwal and Kunreuther, 2000; Habib and Ziegler, 2007; Barrieu and Louberge, 2009).

[†] In Gibson, Habib and Ziegler (2011), the discount which insurers with high loss uncertainty offer serves as compensation to uninformed traders for the losses they are likely to experience when dealing with informed market traders. The discount also equals the information production costs of informed market traders.

3. Data and Methodology

3.1. Data

We obtain data on insurance securitizations before May 2010 from Hannover Re. We select all Cat bonds defined as bonds where coupons and/or principal payments are contingent on the occurrence of catastrophe-related property and casualty risks or catastrophe-related mortality risks.[*] We pool both types of risks, because the bonds' structures are (apart from the trigger event) identical (Cowley and Cummins, 2005) and because the issuing firms in our sample do not operate in distinct markets (i.e. all sample firms issuing mortality-related bonds have at some point also issued property and casualty-related bonds). Further, the findings we present in this paper remain unaffected when we exclude mortality-related Cat bonds from our sample. Finally, we stipulate that Cat bond issuers need to be listed firms which have equity and accounting data available on the Datastream-Worldscope database and that issuers are the ultimate beneficiary of the Cat bond coverage.[†]

For an initial sample of 143 Cat bond issues, we verify the Cat bond data from Hannover Re by matching them with public information on insurance securitizations in AON Capital Markets (2010) and Guy Carpenter (2008). Where discrepancies between proprietary and public data are identified (e.g., as regards the issue date, value and risks underlying an issue), we tried to resolve these by conducting searches on various news sources available on LexisNexis and

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[*] Catastrophe mortality risks result from events which lead to sharp increases in mortality rates such as terrorist attacks or pandemics. Bonds which securitize such risks are referred to as 'mortality (Cat) bonds'. By contrast, we do not include longevity bonds in the sample, because these securitize longevity risk (due to increased life expectancy) and are not linked to catastrophe events (for more details, see Cowley and Cummins, 2005).

[†] Transactions where the Cat bond coverage was sold by the issuer to a third party (i.e. Calabash Re Ltd. I-III by Swiss Re) are not included to avoid convoluted interpretations of our results.

Factiva. Where the discrepancies remain unresolved, we omit the issue from our sample (this affects a total of eight issues).

We then omit issues for any of the following reasons. First, we drop so-called follow-up transactions from shelf offering programs. Shelf offering programs allow firms to issue further Cat bonds at any time. Follow-up transactions tend to be very small and have only a limited amount of information available. This affects 29 issues. Second, when a firm issues more than one Cat bond on the same trading day, the transactions are consolidated into a single issue. This leads to 15 individual transactions being consolidated into three deals.* Third, a further 14 transactions were excluded because the news coverage indicates that confounding events such as earnings announcements, dividend payments or equity and debt issues occurred around the event date.

The final sample used in this study consists of 80 Cat bond issues undertaken by 25 issuing firms. The data from Hannover Re indicate that our sample corresponds to 80% of the total Cat bond risk capital (i.e. the total of bond principal and coupon payments at risk) issued by listed companies up to May 2010.

[Table 1 near here]

Table 1 provides sample descriptives by year (Panel A), trigger type (Panel B), country (Panel C), and issuing firm (Panel D). It is evident from Panel A that the majority of Cat bond transactions (by both number and total risk capital) took place in 2006 and 2007. The subsequent decrease in the number of new issues in 2008 and 2009 can be ascribed to the recent financial crisis and investors' reluctance to invest in securitized assets. Panel B reveals that the vast

* When Cat bond transactions are consolidated, we summed up the risk capital of the individual transactions. For all cases where Cat bonds are consolidated, the trigger types of the individual transactions are identical across constituent issues.

majority of Cat bonds exhibits an index-based trigger (meaning that Cat bond payoffs are independent of the underwriting losses of the issuing firm). Panel C illustrates that most Cat bonds were issued by companies listed in Switzerland, the U.S. and Germany. Finally, Panel D shows that Swiss Reinsurance, Munich Re and Allianz SE are amongst the most frequent issuers in our sample.

3.2. Methodology

In this paper, we analyze the stock market valuation effects linked to a firm's announcement to issue a Cat bond. In an efficient capital market, changes in the market valuation of the issuing firm provide an assessment of the net benefits which issuers will realize from a Cat bond issue. We estimate market-adjusted abnormal returns (AR) as employed by Fuller et al. (2002), Faccio et al. (2006) and others:

$$AR_{it} = r_{it} - r_{mt}, \tag{1}$$

where r_{it} is the return for issuer i on day t and r_{mt} is the return on a Datastream insurance index (which also includes reinsurers) for the country of the issuing firm.[*] We compute the Datastream insurance index as the value-weighted AR of all insurance and reinsurance companies listed on Datastream in the issuer's country which have not issued Cat bonds.[†] We sum AR across days and firms to yield cumulative abnormal returns (CAR). To test for the statistical significance of cumulative abnormal returns, we employ a two tailed t-test as well as the non-parametric Mann-Whitney-Wilcoxon test which is robust to the effects of outliers.

[*] This market return index is appropriate given the composition of our sample which consists of insurance and reinsurance firms.

[†] Our results are qualitatively identical if we use a European insurance index (by aggregating all insurance and reinsurance companies in France, Germany, Switzerland and the UK) instead of the individual return index at country level.

We do not estimate market model-adjusted returns (which effectively yield risk-adjusted returns) for two reasons. First, the market model approach assumes that the estimation period over which market model parameters are estimated is free of the type of event whose value effects are being investigated. If we were to compute risk-adjusted abnormal returns using contaminated estimation periods, the resulting estimates would be unreliable. Since our sample contains a number of repeat issues by the same firm, we do not have the clean time series of return data necessary to implement this approach.[*] Second, Brown and Warner (1980) show that over short-time periods risk-adjusted return values do not significantly improve estimation results as compared to the type of market-adjusted values we employ in this study.

The lack of an official announcement date presents a difficulty when determining the market reaction to Cat bond issues. The issue date of a Cat bond is unsuitable as an announcement date, because Cat bonds are sold on a book-building basis where investment banks contact potential investors in advance of an issue to gauge their interest as regards the size and structure of a new issue. It is, therefore, highly likely that market investors are informed about a firm's intention to issue a Cat bond before the issue date. We follow Thomas (1999) and define the event date as the announcement date, unless the issue date precedes the announcement date, in which case we use the issue date as the event date. For each Cat bond, we identify the day that an issue was first announced by conducting news searches on LexisNexis and Factiva, as well the issuing firm's website and ARTEMIS (www.artemis.bm) an online practitioner portal for insurance securitization. For 80% of sample observations, press announcements of Cat bond

[*] When we allow for overlaps in the estimation period and re-run our regression models using a single index market model ($AR_{it}=r_{it}-\alpha_i-\beta_i r_{mt}$) and an estimation period of 200 trading days (t-226 to t-26 trading days relative to the announcement date t of a Cat bond issue), our main conclusions are not affected. The results of these regressions are available from the authors upon request.

issues precede the issue date (on average by 13 days). This highlights the importance of employing our hand collected announcement dates (rather than the issue dates) as event dates.

4. Univariate Results

4.1. The Shareholder Wealth Effects of Insurance Securitization

In this section, we examine changes in the market value of firms which announce their engagement in insurance securitization by issuing Cat bonds. Given the rather underwhelming contribution of Cat bonds to global catastrophe coverage to date, we do not expect to find strong performance gains for shareholders in the issuing firms.

Table 2 reports abnormal returns linked to new Cat bond issues for selected event windows. Panel A shows that CAR[-15; +15] and CAR[-20; +20] are positive and statistically significant above the 10%-level (yet only according to the *t*-test).[*] While Cowan and Sergeant (1996) argue that non-parametric tests may struggle to detect small levels of abnormal share price performance, the insignificant *z*-statistic means we cannot exclude explanations according to which our finding of value gains is driven by outliers.

[Table 2 near here]

Panel B reports abnormal returns around the issue date of Cat bonds. Since any press coverage has preceded the issue date for the vast majority of Cat bond issues, we do not expect to find any statistically significant valuation effects around the issue. Our results in Panel B are consistent with this expectation and confirm our rationale for centering the event study around announcement dates rather than issue dates.

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[*] The use of multi-week event periods is consistent with studies examining the shareholder wealth effects of asset securitization in the banking sector. For instance, Thomas (1999, 2001) uses a 50-day event window.

In sum, we do not find evidence that Cat bond issues, on average, lead to strong performance gains for shareholders in the issuing firm. However, Table 2 also reports that the sample is nearly split in half as regards sample firms experiencing value gains and value losses from Cat bond issues. This points towards large variations in the distribution of Cat bond effects. The next sections, therefore, identify some of the factors which determine the market reaction to Cat bonds. This will lead to a better understanding of the motivations why firms engage in insurance securitization. Based on the two main sources for firm gains from issuing Cat bonds identified in Section 2, we group these factors into hedging benefits and cost benefits.

4.2. Value Effects and Hedging Benefits

As previously noted, one reason why firms could benefit from Cat bond issues is that Cat bonds allow firms to hedge against catastrophe-related underwriting losses by transferring catastrophe risks to capital markets. Since very few Cat bonds have been triggered by a natural catastrophe to date, we are unable to measure the hedge efficiency of Cat bonds by matching Cat bond payoffs with insurer losses. Instead, we use two proxies to gauge the hedging benefits likely to be realized by the issuer: the trigger types underlying Cat bonds and the initial bond rating.

The first proxy we use to measure any hedging benefits realized by the issuers is the trigger type. Our sample contains three types of triggers. (i) Indemnity based triggers, where the conditions for principal and/or coupon forfeiture are defined in terms of the underwriting losses of the issuer, (ii) index based triggers, where payouts are based on a loss index, and (iii) hybrid triggers, which combine more than one trigger in a single Cat bond. Indemnity-based triggers provide a perfect hedge against catastrophe-related losses of the issuing firm and should, therefore, provide the greatest hedging benefits to firms issuing Cat bonds.

However, indemnity-based Cat bonds suffer from a well-defined moral hazard problem. Since issuers are better informed about the loss functions linked to particular risks than market investors, they may issue high-risk bonds to unsuspecting investors (Doherty, 1997). Furthermore, indemnity-based Cat bonds display higher transaction costs resulting from higher disclosure requirements on the part of the issuer over the securitized risks. While index-linked and hybrid triggers are subject to a lower degree of moral hazard (and, thus, carry lower transaction costs for issuers), they both involve substantial basis risk when Cat bond payoffs are independent of the losses realized by the issuer. A priori it is, therefore, not obvious which trigger type will bring larger benefits to the issuer. We propose, however, that if the main benefit of Cat bonds lies in hedging catastrophe-related risks, indemnity-based Cat bonds should lead to higher abnormal returns.

[Table 3 near here]

Table 3 examines the market valuation effects linked to Cat bond issues by trigger type for different event windows. We distinguish between indemnity-based triggers as well as non-indemnity triggers. Overall, the results show that abnormal returns surrounding the announcement to issue Cat bonds do not differ by the type of trigger. Differences in the abnormal returns for indemnity-based Cat bonds as compared with non indemnity-based Cat bonds are not statistically significant at customary levels (based on either a *t*-test or the non-parametric Mann-Whitney-Wilcoxon test). While we find statistically significant abnormal returns according to a *t*-test for non indemnity-based Cat bonds over [-15, +15] (at 10%-level of significance), Table 3 provides no further evidence that the value effects linked to Cat bond issues differ by the type of trigger event underlying an issue.

The second proxy we use to measure any hedging benefits realized by the issuers is the initial Cat bond rating by Standard & Poor's (or, if unavailable, by Moody's).[*] Since Cat bonds involve no credit risk (as their principals are fully collateralized), lower ratings indicate that the catastrophe loss event underlying the bond is more likely to occur. Given capacity constraints in reinsurance markets due to the inability of reinsurers to fully diversify underwriting losses caused by catastrophe events (see Froot and Stein, 1998; Froot and O'Connell, 2008), issuers will find it particularly difficult to obtain coverage in reinsurance markets for the type of loss events underlying Cat bonds with low ratings. Therefore, if the main benefit of Cat bonds lies in hedging catastrophe-related risks, we expect to find that for high-risk catastrophes (i.e. for Cat bonds with low ratings), Cat bonds should result in higher revaluation gains for the issuing firm.

[Table 4 near here]

Table 4 examines the market valuation effects linked to Cat bond issues by bond rating. Specifically, we report abnormal returns for different event windows surrounding the announcement to issue Cat bonds for both the ten highest and lowest rated bonds. Bond ratings are converted into a numerical scale where higher numbers indicate a lower rating.[†] The results in Table 4 show that Cat bond ratings do not impact on abnormal returns surrounding the issue announcement. Thus, differences between the ten highest and lowest rated Cat bonds are all statistically insignificant at customary levels (based on either a *t*-test or the non-parametric Mann-Whitney-Wilcoxon test).

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[*] Since Cat bonds often consist of several tranches with separate ratings, the rating we assign to an issue is an average weighted by the risk capital underlying each tranche.

[†] The numerical conversion applied to Cat bond ratings is as follows. We assign the value of one to an issue which is rated AAA (or Aaa rated by Moodys), two to an AA+ (or Aa1) bond issue, and so on down to 17 for a CCC+ (or Caa) and 18 for 'Not Rated'. In our sample, nearly 60% of observations attract a rating between BB+ (or Ba1) and BB (or Ba2), i.e. between the values 11 and 12.

4.3. Value Effects and Cost Benefits

Next to hedging benefits, firms may also benefit from Cat bonds by realizing cost savings on catastrophe-related risk management. To analyze whether firms issue Cat bonds to realize cost savings on catastrophe-related risk management, we examine how loss uncertainty and the prices of catastrophe coverage via reinsurance markets affect the market reaction to a Cat bond issue.

First, loss uncertainty facing the issuer may prove costly to the issuer of Cat bonds. Gibson, Habib and Ziegler (2011) develop a theoretical model where loss uncertainty gives rise to increased information acquisition costs which are borne by insurers that seek catastrophe coverage via financial markets. These additional costs arise because insurers which face greater loss uncertainty need to offer a discount on the price of any securities issued to uninformed market participants. This discount is designed to compensate uninformed market participants for the likely losses they will experience when dealing with more informed traders under high loss uncertainty.

[Table 5 near here]

Table 5 tests this proposition. To capture loss uncertainty, we use the volatility of the issuer's loss ratio in the four fiscal years before the announcement date as in De Haan and Kakes (2010).[*] Table 5 reports abnormal returns for different event windows surrounding the announcement to issue Cat bonds in the lowest (Q_1) and highest (Q_5) quintile of the distribution of issuers' loss uncertainty.

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[*] Loss ratios are defined as the sum of claim and loss expenses and long-term insurance reserves scaled by premium income as in Browne and Hoyt (1995) and Cummins and Xie (2008). To address concerns that loss ratios are not comparable across property/casualty and life insurers, we re-run both univariate as well as multivariate tests after excluding life insurers. We find that our main conclusions remain unaffected.

In line with our proposition and Gibson, Habib and Zieglers' (2011) arguments, Table 5 documents that issuers with lower loss uncertainty benefit more from issuing Cat bonds than issuers with more volatile loss ratios. Over most event windows, issuers with low loss uncertainty realize higher abnormal returns than issuers with high loss uncertainty (significant at 10% for both *t*-test and *z*-test).

Second, we turn to the pricing of catastrophe coverage. Since the pricing of catastrophe coverage varies across the reinsurance underwriting cycle, the extent to which the gains from issuing Cat bonds vary across the reinsurance underwriting cycle provides an additional indicator of whether firms issue Cat bonds to realize costs savings on catastrophe-related risk management.

The reinsurance underwriting cycle is characterized by periods when reinsurance prices are relatively low and coverage is readily available (soft markets) and periods when reinsurance prices are high and coverage supply is restricted (hard markets). Hard markets tend to follow time periods in the aftermath of natural catastrophes (Froot and O'Connell, 2008). Lane and Mahul (2008) show that Cat bond spreads are positively related to the reinsurance underwriting cycle. Consequently, when the costs of reinsurance are high, the costs of catastrophe coverage via Cat bonds are high as well. The critical cost advantage of Cat bonds lies in the fact that the costs of catastrophe coverage are fixed over a multiyear period (of usually three to four years) at the time of the issue. Therefore, Cat bonds issued during soft markets effectively lock in low catastrophe pricing and may result in substantial cost savings should reinsurance markets harden in the following years. By the same token, issues during hard markets mean that the issuer is likely to pay a high price for catastrophe coverage when reinsurance markets soften again. If the costs of obtaining catastrophe coverage are an important driver of the benefits linked to Cat bond issues, we propose that the value effects linked to issuing Cat bonds during hard reinsurance markets will be lower than the value effects generated by issuing Cat bonds during soft reinsurance markets.

In order to distinguish between soft markets and hard reinsurance markets, we use the Guy Carpenter (2010) World Catastrophe Rate On Line Index. The index values essentially equate to the average premium per dollar of reinsurance coverage (defined as global catastrophe reinsurance premiums divided by the global policy limits of catastrophe reinsurance). Table 6 reports abnormal returns for different event windows surrounding the announcement to issue Cat bonds for the lowest (Q_1) and highest quintile (Q_5) of the distribution of the Rate On Line index.

[Table 6 near here]

Table 6 confirms our proposition. Over all event windows we examine, Cat bond issues during soft markets lead to higher abnormal returns for issuing firms compared with issues during hard markets. These results are statistically significant according to the *t*-test for all event windows and also according to a z-test (for [-20; +20] and [-25; +25]). This suggests that lowering the costs of catastrophe coverage is an important source of gains for the issuers of Cat bonds.

Overall, we conclude that the wealth effects in response to the issue announcement of Cat bonds appear to be driven by explanations according to which Cat bonds offer cost savings versus other forms of catastrophe risk management (and less by their potential to hedge exposure to catastrophe risk). To test whether additional factors impact upon the shareholder wealth effects of insurance securitization, we run multivariate regression analyses in the next section.

5. The Determinants of the Wealth Effects of Insurance Securitization

5.1. The Model

We use multivariate regression analyses to assess the robustness of our findings in the univariate analysis and to jointly estimate the various factors which affect the market reaction to firms issuing Cat bonds. Specifically, we estimate the following model via OLS with robust standard errors.*

$$\mathbf{CAR}[-20;\ +20] = \alpha + \gamma'\mathbf{IC} + \theta'\mathbf{BC} + \delta'\mathbf{MC} + \varepsilon\,, \tag{2}$$

where:

- CAR[-20; +20] is the market-adjusted mean cumulative abnormal return over [-20; +20] days relative to the announcement date;
- **IC** is a vector of issuer characteristics in the fiscal year before the issue;
- **BC** is a vector of Cat bond characteristics, and
- **MC** is a vector of market specific characteristics.

To control for the effect of unobserved variables that are constant over time, we include year fixed effects into our model. Also, because observations for specific issuers are unlikely to be independent (possibly leading to within correlation issues), we compute cluster-robust standard errors and treat each issuing firm as a cluster.

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* Given the sample size of 80 observations we also implemented the bootstrapping pairs procedure (see Efron and Tibshirani, 1993) with 1,000 bootstrap replications to evaluate the statistical significance of estimated coefficients to test the robustness of the results. Also, to test whether the regression results are robust to the effects of outliers we used quantile regressions. We find that our main conclusions are not affected by using either the bootstrapping pairs procedure or quantile regressions. The full results of the bootstrapping pairs procedure and quantile regressions are available from the authors upon request.

Table 7 presents descriptions and summary statistics for the vector of variables described below. All accounting data (unless stated differently) refer to one fiscal year prior to the announcement of the Cat bond issue (*t*-1) and are from Worldscope.

[Table 7 near here]

5.1.1. Issuer Characteristics

The vector of issuer characteristics contains firm size (**SIZE**) which is measured by the logarithm of issuer total assets. We expect firm size to enter the model with a positive coefficient for three reasons. First, large companies should possess the financial sophistication and adequate mass to produce transactions of sufficient scale to amortize the high structuring costs of Cat bonds (Cummins and Trainar, 2009). Second, it is conceivable that larger firms are more likely to boast sizable asset management divisions which facilitate access to potential Cat bond investors. Third, basis risk involved in the transaction is likely to decrease with the size of the issuing firm (Harrington and Niehaus, 1999).

Another issuer characteristic is the issuer's leverage (**LEV**; defined as total liabilities over total assets) which measures a firm's exposure to financial distress. We expect that firms with higher leverage will generate positive announcement returns, because securitization is a means to free up capital that can then be used to absorb losses and avoid financial distress following a catastrophe event (Cummins and Trainar, 2009). We also control for accounting and market performance before the time period of an issue. For accounting performance, we use return on equity (**ROE**; defined as pre-tax profits over book value of equity). For pre-issue market performance, we use issuers' buy and hold abnormal returns (**PREPERF**) over [-252; -20] days relative to the announcement date net of the return for our Datastream insurance index at country-level over the same time period. Against the background that shareholder may be unfamiliar with the concept of Cat bonds, we expect to find a positive association between both performance measures and announcement returns. This would indicate that shareholders place more confidence in the performance effects of Cat bonds issued by highly performing firms.

We also include the issuers' loss volatility (**LOSSVOL**). In line with the univariate tests above, we define loss volatility as the standard deviation of the loss ratio (defined as the sum of claim and loss expenses as well as long-term insurance reserves scaled by premium income) in the four fiscal years before the announcement date. We expect LOSSVOL to have a negative effect on abnormal returns, meaning that issuers with more stable loss ratios will benefit more from issuing Cat bonds as insurance securitization offers them relatively greater cost savings compared with reinsurance coverage (cf. Gibson, Habib and Ziegler 2011).[*]

FREQUENT is a proxy for the experience of the issuing firm in the Cat bond market. This variable is defined as a dummy variable which equals one if the issuer has issued five or more Cat bonds during the observation period (and zero otherwise).[†] Evidence from the banking sector shows that frequent securitizations are rewarded with higher excess shareholders returns (Thomas, 2001). These findings are explained by potential knowledge and reputation gains as well as greater bargaining power vis-à-vis investors when structuring follow-up issues. As a

[*] We also control for the type of issuer, by including a dummy variable which is equal to one when the issuer is a reinsurance firm and 0 otherwise (REINSURER). We find that REINSURER enters the model with a statistically insignificant coefficient while the results remain the same. Nevertheless, as REINSURER is highly correlated with the size of the issuer (SIZE), we exclude the variable from our model.

[†] As an alternative measure to FREQUENT, we also employ the number of previous Cat bond issues as a proxy for the issuer's experience, as suggested by Thomas (2001). We find that regression results did not change by using this measure instead of FREQUENT.

result, we expect the announcement by a firm which has already issued five or more Cat bonds to be associated with positive abnormal returns.

5.1.2. Cat Bond Characteristics

The vector of Cat bond controls contains the following variables. The size of the issue (**ISSUESIZE**) is computed as the ratio of total risk capital issued to the book value of equity. Since Cat bond issues display a high proportion of fixed transaction costs, larger issues should be more cost efficient (Cummins and Trainar, 2009) and should, therefore, generate higher abnormal returns. In line with the univariate tests, we further control for the type of trigger event underlying Cat bonds. **INDEM** is a dummy variable which is equal to one when an indemnity trigger is used (and zero otherwise). As explained in Section 4.2, if the main benefit of Cat bonds lies in hedging catastrophe-related risks, we expect INDEM to enter the model with a positive coefficient. Also in line with the univariate tests, we control for the initial Cat bond rating (**BONDRATING**) by Standard & Poor's (or, if unavailable, by Moody's) with 1 being the highest rated bond and 18 being not rated. If the main benefit of Cat bonds lies in hedging catastrophe-related risks, we would expect the coefficient on BONDRATING to enter the model with a positive sign, indicating that Cat bonds with a lower rating (meaning the catastrophe loss event underlying the bond is more likely to occur) lead to higher abnormal returns.

Since Cat bonds can be used to securitize either catastrophe-related property and casualty risks or catastrophe-related mortality risks, we also control for the securitized type of risk by adding **MORTALITY** to the model. MORTALITY takes a value of one if the bond securitizes catastrophe-related mortality risks (and zero otherwise). Against the background that mortality bonds are much less frequently used we expect shareholders to be more uncertain about mortality bonds' potential performance effects. Consequently, MORTALITY should have negative value implications for the issuing firms.

5.1.3. Market Characteristics

Finally, moving on to the vector of market characteristics, we use the Guy Carpenter Rate On Line Index to compute **SOFTMARKET**, a dummy variable which equals one if the issue announcement takes place during particular soft reinsurance markets (defined as the lowest quintile of the sample distribution of the Guy Carpenter Rate On Line Index). In line with our univariate tests, we expect to find a positive association between SOFTMARKET and announcement returns, because Cat bond spreads are positively related to the reinsurance underwriting cycle (Lane and Mahul, 2008).

5.2. Regression Results

Table 8 presents the results of regressions on the announcement period returns (CAR[-20;+20]) around the announcement of a Cat bond issue. The results confirm our main findings from the univariate tests above. First, INDEM and BONDRATING do not enter with a statistically significant coefficient, suggesting that the hedging potential of Cat bonds do not impact on the value effects linked to insurance securitization. Second, LOSSVOL enters the model with negative coefficients (significant at the 1% level). This is consistent with issuers with more stable loss ratios realizing larger cost savings from Cat bonds vis-à-vis reinsurance coverage. This is in line with Gibson, Habib and Ziegler (2011) who argue that insurance securitization involves lower information acquisition costs as compared to traditional reinsurance when expected losses can be predicted involving little uncertainty.

Third, reinsurance prices affect the benefits that issuers expect to extract from the issue of a Cat bond. SOFTMARKET enters with a positive and statistically significant coefficient (significant at the 5% level), indicating that Cat bond issues during periods of particularly low reinsurance prices lead to higher abnormal returns for issuing firms. As argued earlier, this can be ascribed to the fact that Cat bond prices are locked in for a multi-year period and, consequently, Cat bond prices remain unaffected by future price increases in the market for catastrophe coverage. By and large, these results confirm that market investors take the view that the source of performance gains for firms engaging in insurance securitization lies in these firms realizing cost efficiencies compared with reinsurance coverage.

[Table 8 near here]

Further, the control variables show that firms which are less exposed to financial distress (LEV), as well as firms with higher pre-issue market performances (PREPERF) realize higher abnormal returns (significant at the 5% level). We jointly interpret these findings as consistent with explanations according to which investors are uncertain about the performance implications of Cat bonds. It could be argued that investors focus on measures of the issuer's recent performance and financial stability to gauge the expected performance effects of a Cat bond on the issuing firm.

Also, and consistent with the last point, it is interesting to note a general absence of control variables linked to the Cat bond design which enter the regressions with a statistically significant sign. Consequently, it could be argued that shareholders are either indifferent about the design of Cat bonds or, alternatively, they are uncertain over the performance effects of Cat bond design on the issuing firm.

6. Summary and Conclusions

The recent earthquake and tsunami in Japan is estimated to be the second most costly insurance loss after Hurricane Katrina in 2005. These and similar catastrophe loss events bear testimony to a remarkable increase in catastrophe-related underwriting losses over the past decade. Traditional insurance and reinsurance markets struggle to cope with this situation. Therefore, firms exposed to catastrophe-related underwriting losses have been seeking alternative risk transfer solutions, most prominently in the form of Cat bonds which are designed to transfer catastrophe-related risks to capital markets.

For firms with catastrophe-related underwriting exposures, issuing Cat bonds should offer a number of potential benefits. However, many of the arguments made in favor of Cat bonds do not take into account supply-side or demand-side frictions in the market for catastrophe risks. Over the years, this has led to considerable uncertainty over whether Cat bonds actually benefit the firms which issue them. In this paper, we empirically examine the shareholder wealth effects for a unique data set consisting of the near population of Cat bond issues by listed companies up to May 2010.

Consistent with the underwhelming contribution which Cat bonds make to global catastrophe coverage to date, we do not find evidence of strong performance gains for the shareholders of firms which issue Cat bonds. Further examination reveals that the value effects linked to insurance securitization appear to be driven by explanations according to which Cat bonds offer cost savings versus other forms of catastrophe risk management (and less by their potential to hedge exposure to catastrophe risk). Issues by firms facing low levels of loss uncertainty (which reduces the information acquisition costs in financial markets) as well as issues during time periods in which the premiums for catastrophe coverage are particularly low (and coverage via Cat bonds is inexpensive) experience large value gains linked to Cat bond issues.

Given the relatively low number of Cat bond issues to date and the long time period we examine, our results have to be interpreted with suitable caution and should be seen as suggestive rather than compelling. However, we argue that, overall, our results draw a positive picture of the expected performance effects of Cat bonds on the firms which issue them. Arguably, Cat bonds may well have additional positive effects on firms with catastrophe-related risks which our empirical approach is unable to detect. For instance, Cat bonds may have increased competition for catastrophe reinsurance and, thereby, lowered catastrophe reinsurance premiums for all firms (see Froot, 2001). While the present paper tries to gauge the effect of Cat bonds on issuing firms, the benefits of Cat bonds may have been more universal and may have also affected firms which have not issued them.

Future empirical work on the effects of Cat bonds on issuing firms should do more to address the risk effects of insurance securitization on issuing firms. Even though our results point to the issuer-specific benefits of Cat bonds being linked to the pricing of catastrophe coverage and less to Cat bonds as a means of hedging catastrophe-related risk, little is known to date about the effects that Cat bond issues have on the riskiness of issuing firms. Theoretical work continues to posit that Cat bonds are a means for firms to hedge catastrophe-related risks which should, therefore, have measurable risk effects on the issuing firm. Future work should, therefore, investigate the risk effects of Cat bond issues, for instance, by examining the impact that insurance securitization has on market measures of issuer risk.

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Table 1
Sample Characteristics

Panel A: Cat Bond Issues by Year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Number	1	1	3	4	6	3	2	1	5	12	17	10	9	6	80
Risk capital $ (millions)	112	45	322	604	797	356	605	248	1,007	3,344	4,043	1,638	1,290	850	15,261
% Value	0.73	0.29	2.11	3.95	5.21	2.33	3.95	1.62	6.58	21.86	26.42	10.71	8.43	5.56	100.00

Panel B: Cat Bond Issues by Trigger Type

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Indemnity	0	1	1	0	0	0	0	0	1	2	2	3	1	0	11
Index	1	0	2	4	6	3	2	1	3	9	12	5	6	5	59
Hybrid	0	0	0	0	0	0	0	0	1	1	3	2	2	1	10

Panel C: Cat Bond Issues by Country

	France	Germany	Japan	Switzerland	UK	U.S.	Total
Number	9	18	3	24	3	23	80
Risk Capital $ (millions)	2,164	2,944	748	5,215	408	3,782	15,261
% Value	14.15	19.24	4.89	34.08	2.67	24.72	100.00

Panel D: Cat Bond Issues by Issuing Firm

Firm	No.	Firm	No.	Firm	No.
Allianz SE	5	Flagstone Reinsurance Holdings Ltd.	2	PXRE Group Ltd.	2
Allstate Corp.	2	Hannover Re	3	Scor SE	4
Aspen Insurance Holdings	1	Hartford Financial Service Group Inc.	3	Swiss Reinsurance Company Ltd.	18
Assurances Generales De France (AGF)	1	Hiscox Ltd.	1	Tokio Marine Holdings Inc.	1
Assurant Inc.	2	Mitsui Sumitomo Insurance Group Holdings Inc.	1	Travelers Companies Inc.	4
AXA S.A.	4	Montpelier Re Holdings Ltd.	1	Vesta Insurance Group Inc.	1
Catlin Group Ltd.	2	Munich Re Group	10	Zurich Financial Services AG	6
Chubb Corp.	3	Nissay Dowa General Insurance Company Ltd.	1		
Endurance Specialty Holdings Ltd.	1	Platinum Underwriters Holdings Ltd.	1		

Table 2
Abnormal Returns for Selected Event Windows

	N	mean (%) (*t*-stat)	median (%) (*z*-stat)	CAR>0% N	CAR>0% %
Panel A: Distribution by Announcement Date					
CAR[-5;+5]	80	0.38	-0.20	37	46.3
		(0.77)	(-0.11)		
CAR[-10;+10]	80	1.01	0.20	42	52.5
		(1.50)	(0.56)		
CAR[-15;+15]	80	**1.55**	0.85	43	53.8
		(2.00)**	(1.25)		
CAR[-20;+20]	80	**1.45**	0.11	43	53.8
		(1.67)*	(0.93)		
CAR[-25;+25]	80	0.78	0.41	44	55.0
		(0.94)	(0.47)		
Panel B: Distribution by Issue Date					
CAR[-5; +5]	80	0.08	-0.20	39	48.8
		(0.14)	(-0.10)		
CAR[-10;+10]	80	0.97	0.52	44	55.0
		(1.39)	(1.26)		
CAR[-15;+15]	80	0.93	-0.33	39	48.8
		(1.10)	(-0.47)		
CAR[-20;+20]	80	0.88	-0.02	40	50.0
		(0.96)	(-0.08)		
CAR[-25;+25]	80	0.41	0.05	41	51.3
		(0.47)	(0.33)		

Notes: The table reports cumulative abnormal returns (CAR) for both the announcement date (Panel A) and the issue date (Panel B) of Cat bond issues during the period 1997 to May 2010 for different event windows. In both cases, abnormal returns are estimated using a market model:

$$AR_{it} = R_{it} - R_{mt}$$

where R_{it} is the observed arithmetic return for issuing firm i at day t and R_{mt} is the value-weighted market index return for day t. Also included are t-statistics (two tailed) and the non-parametric Mann–Whitney–Wilcoxon Z-scores. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3
Value Effects by Trigger Event

		CAR[-5;+5]	CAR[-10;+10]	CAR[-15;+15]	CAR[-20;+20]	CAR[-25;+25]
Indemnity	mean	-0.42%	-0.04%	1.03%	1.27%	-0.58%
N=11	(*t*-stat)	(-0.37)	(-0.02)	(0.43)	(0.37)	(-0.14)
	median	-0.47%	-0.14%	-0.37%	-0.44%	-0.31%
	(*z*-stat)	(-0.46)	(-0.05)	(-0.15)	(-0.26)	(-0.25)
Other	mean	0.50%	1.16%	**1.62%**	1.47%	0.97%
N=69	(*t*-stat)	(0.91)	(1.58)	**(1.91)***	(1.64)	(1.26)
	median	-0.13%	0.20%	1.13%	0.27%	0.41%
	(*z*-stat)	(-0.06)	(0.64)	(1.36)	(0.85)	(0.64)
$\mathbf{\Delta CAR_{INDEM\text{-}OTHER}}$	mean	-0.92%	-1.20%	-0.59%	-0.20%	-1.55%
	(*t*-stat)	(-0.61)	(-0.59)	(-0.24)	(-0.08)	(-0.62)
	median	-0.34%	-0.06%	-1.50%	-0.77%	-0.72%
	(*z*-stat)	(-0.46)	(-0.21)	(-0.62)	(0.10)	(-0.53)

Notes: The table reports market adjusted cumulative abnormal returns (CAR) for different event windows surrounding the announcement to issue Cat bonds for indemnity based and non-indemnity based Cat bonds, respectively. Also, the differences in CAR between indemnity based and non-indemnity based Cat bonds are displayed ($\Delta CAR_{INDEM\text{-}OTHER}$). The sample consists of 80 Cat bonds issued in the period 1997 to May 2010. All firms are publicly traded. To test for the statistical significance of CAR, we employ a two tailed *t*-test as well as the non-parametric Mann–Whitney–Wilcoxon test. * indicates significance at the 10 % level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 4
Value Effects by Cat Bond Ratings

		CAR[-5;+5]	CAR[-10;+10]	CAR[-15;+15]	CAR[-20;+20]	CAR[-25;+25]
High Rating	mean	0.17%	2.13%	0.44%	-0.59%	-0.38%
N=10	(*t*-stat)	(0.37)	(0.93)	(0.31)	(-0.35)	(-0.31)
	median	0.40%	-0.78%	-0.50%	-2.94%	-1.26%
	(*z*-stat)	(0.36)	(0.25)	(-0.25)	(-1.27)	(-0.66)
Low Rating	mean	0.67%	0.79%	0.15%	0.47%	0.08%
N=10	(*t*-stat)	(0.72)	(0.76)	(0.13)	(0.37)	(0.11)
	median	-0.13%	0.46%	0.35%	-0.56%	0.22%
	(*z*-stat)	(0.56)	0.76	(0.25)	(0.05)	(0.25)
$\Delta CAR_{HIGH-LOW}$	Δmean	-0.50%	1.33%	0.29%	-1.07%	-0.45%
	(*t*-stat)	(-0.49)	(0.53)	(0.16)	(-0.49)	(-0.33)
	Δmedian	0.53%	-1.24%	-0.85%	-2.38%	-1.48%
	(*z*-stat)	(-0.23)	(-0.61)	(-0.23)	(-1.05)	(-0.75)

Notes: The table reports market adjusted cumulative abnormal returns (CAR) for different event windows surrounding the announcement to issue Cat bonds for both the ten highest and lowest rated bonds. The bond rating is applied by Standard &Poor's or Moody's with 1 being the highest rated bond and 18 being not rated Also, the differences in CAR between the ten highest and lowest rated bonds are displayed ($\Delta CAR_{HIGH-LOW}$). The sample consists of 80 Cat bonds issued in the period 1997 to May 2010. All firms are publicly traded. To test for the statistical significance of CAR, we employ a two tailed *t*-test as well as the non-parametric Mann–Whitney–Wilcoxon test. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 5
Value Effects by the Issuer's Loss Uncertainty

		CAR[-5;+5]	CAR[-10;+10]	CAR[-15;+15]	CAR[-20;+20]	CAR[-25;+25]
Low (Q_1)	mean	4.43%	**7.02%**	7.98%	6.77%	2.84%
N=16	(*t*-stat)	(1.09)	**(1.75)***	(1.38)	(1.24)	(0.55)
	median	1.26%	**3.19%**	4.37%	2.92%	2.61%
	(*z*-stat)	(1.15)	**(2.31)****	(1.36)	(1.36)	(0.52)
High (Q_5)	mean	0.35%	1.04%	1.30%	1.29%	1.00%
N=16	(*t*-stat)	(0.68)	(1.45)	(1.50)	(1.26)	(1.04)
	median	0.14%	0.45%	0.97%	-0.10%	0.30%
	(*z*-stat)	(0.58)	(0.26)	(1.27)	(0.60)	(0.51)
$\Delta CAR_{Q1\text{-}Q5}$	Δmean	**4.08%**	**5.97%**	**6.68%**	5.49%	1.84%
	(*t*-stat)	**(2.07)****	**(2.38)****	**(2.11)****	(1.56)	(0.56)
	Δmedian	1.12%	**2.74%**	3.40%	3.02%	2.31%
	(*z*-stat)	(0.98)	**(1.80)***	(1.16)	(1.13)	(0.27)

Notes: The table reports market adjusted cumulative abnormal returns (CAR) for different event windows surrounding the announcement to issue Cat bonds for the lowest (Q_1) and highest quintiles (Q_5) for the standard deviation of the loss ratio in the four fiscal years before the announcement date. The loss ratio is defined as claim and loss expenses plus long-term insurance reserves scaled by premium income (all in *t*-1). Also, the differences in CAR between the lowest and highest quintile are reported ($\Delta CAR_{Q1\text{-}Q5}$). The sample consists of 80 Cat bonds issued in the period 1997 to May 2010. All firms are publicly traded. To test for the statistical significance of CAR, we employ a two tailed *t*-test as well as the non-parametric Mann–Whitney–Wilcoxon test. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 6
Value Effects by Reinsurance Prices

		CAR[-5;+5]	CAR[-10;+10]	CAR[-15;+15]	CAR[-20;+20]	CAR[-25;+25]
Guy Carpenter Rate On Line Index						
Low (Q_1)	mean	3.78%	4.04%	6.34%	6.91%	3.11%
N=20	(*t*-stat)	(0.98)	(0.99)	(1.29)	(1.23)	(0.67)
	median	0.55%	3.42%	4.15%	7.85%	6.25%
	(*z*-stat)	(0.28)	(0.70)	(1.12)	(1.26)	(0.70)
High (Q_5)	mean	-0.46%	**-1.08%**	-0.93%	**-1.58%**	**-2.17%**
N=13	(*t*-stat)	(-0.97)	**(-1.70)***	(-1.17)	**(-2.17)****	**(-2.77)*****
	median	-1.04%	-0.95%	-0.61%	**-1.12%**	**-1.70%**
	(*z*-stat)	(-1.07)	(-1.48)	(-0.92)	**(-1.85)***	**(-2.41)****
$\Delta CAR_{Q1\text{-}Q5}$	Δmean	**4.25%**	**5.11%**	**7.27%**	**8.48%**	**5.28%**
	(*t*-stat)	**(1.96)***	**(2.14)****	**(2.50)****	**(2.69)****	**(1.91)***
	Δmedian	1.59%	4.37%	4.76%	**8.97%**	**7.95%**
	(*z*-stat)	(0.55)	(0.92)	(0.85)	**(1.77)***	**(2.04)****

Notes: The table reports market adjusted cumulative abnormal returns (CAR) for different event windows surrounding the announcement to issue Cat bonds for the lowest (Q_1) and highest quintiles (Q_5) for the Guy Carpenter Rate On Line Index (Source: Guy Carpenter, 2010). We use this index as a measure of the reinsurance price level. Also, the differences in CAR between the lowest and highest quintile are reported ($\Delta CAR_{Q1\text{-}Q5}$). The sample consists of 80 Cat bonds issued in the period 1997 to May 2010. All firms are publicly traded. To test for the statistical significance of CAR, we employ a two tailed *t*-test as well as the non-parametric Mann–Whitney–Wilcoxon test. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 7
Summary Statistics

	Variable	Definition	N	Mean	Median	Std. Dev	5 Pctile	95 Pctile
Value effect	CAR[-20;+20]	Market-adjusted mean cumulative abnormal return over [-20; +20] days relative to the announcement date (%)	80	1.45	0.11	7.90	-8.92	17.48
Issuer characteristics	SIZE	Log of total assets	80	18.36	18.87	1.62	14.94	20.84
	LEV	Total liabilities to total assets (%)	80	85.47	89.43	13.03	61.86	95.93
	ROE	The ratio of pre-tax profits to equity (%)	80	16.18	17.59	10.61	-3.19	31.70
	PREPERF	Buy and hold abnormal return from -252 to -20 days relative to the announcement date (%)	80	0.25	-2.52	22.25	-27.40	34.72
	LOSSVOL	Standard deviation of loss ratios (defined as claim and loss expenses plus long-term insurance reserves scaled by premium income) over a four-year period prior to the announcement date	80	6.45	4.62	6.08	1.24	18.02
	FREQUENT	Dummy which equals 1 if the issuer has issued five or more Cat bonds during the observation period (and 0 otherwise)	80	0.49	0.00	0.51	0.00	1.00
Cat bond characteristics	ISSUESIZE	Value of Cat bond issue scaled by the book value of equity (%)	80	2.61	1.45	3.25	0.31	10.60
	INDEM	Dummy which equals 1 if the Cat bond has an indemnity trigger (and 0 otherwise)	80	0.13	0.00	0.33	0.00	1.00
	BONDRATING	The bond rating applied by Standard &Poor's or Moody's with 1 being the highest rated bond and 18 being not rated	80	11.39	11.43	2.55	5.39	14.91
	MORTALITY	Dummy which equals 1 if the Cat bond securitizes mortality-related risks (and 0 otherwise)	80	0.07	0.00	0.27	0.00	1.00
Market characteristics	SOFTMARKET	Dummy which equals 1 if the announcement to issue a Cat bond took place during the lowest quintile for the Guy Carpenter Rate On Line Index (and 0 otherwise). Source: Guy Carpenter (2010).	80	0.25	0.00	0.30	0.00	1.00

Notes: Accounting data (unless stated differently) refer to one fiscal year prior to the announcement of the Cat bond issue and are from Worldscope.

Table 8
Regressions on Abnormal Issuer Announcement Returns

	(A)	(B)	(C)	(D)	(E)	(F)
SIZE	0.813	0.385	0.391	0.854	0.836	
	(0.45)	(0.26)	(0.27)	(0.58)	(0.57)	
LEV	**-0.217****	**-0.180****	**-0.180****	**-0.189****	**-0.189****	**-0.172*****
	(2.65)	**(2.23)**	**(2.20)**	**(2.23)**	**(2.22)**	**(5.27)**
ROE	0.021	0.003	0.001	-0.014	-0.012	
	(0.28)	(0.04)	(0.02)	(0.18)	(0.16)	
PREPERF	**0.083****	**0.074****	**0.074****	**0.077****	**0.077****	**0.073****
	(2.24)	**(2.25)**	**(2.24)**	**(2.31)**	**(2.36)**	**(2.36)**
LOSSVOL	**-0.391*****	**-0.351*****	**-0.351*****	**-0.364*****	**-0.368*****	**-0.323*****
	(3.04)	**(3.08)**	**(2.97)**	**(3.13)**	**(3.06)**	**(3.51)**
FREQUENT	-1.720	-0.808	-0.744	-1.674	-1.793	
	(0.71)	(0.70)	(0.52)	(1.17)	(1.02)	
ISSUESIZE	0.093	0.172	0.174	0.258	0.247	
	(0.13)	(0.31)	(0.32)	(0.46)	(0.46)	
INDEM	-1.595		-0.148		-0.484	
	(0.53)		(0.06)		(0.18)	
BONDRATING	0.360			0.363	0.375	
	(1.48)			(1.67)	(1.68)	
MORTALITY	1.179		-0.791	1.122	1.168	
	(0.56)		(0.70)	(0.60)	(0.61)	
SOFTMARKET	**1.555****	**1.491****	**1.494****	**1.424****	**1.419****	**1.611*****
	(2.25)	**(2.42)**	**(2.36)**	**(2.25)**	**(2.20)**	**(3.00)**
Intercept	0.803	9.187	9.025	-1.630	-1.307	14.802***
	(0.03)	(0.44)	(0.45)	(0.08)	(0.06)	(5.31)
Observations	80	80	80	80	80	80
Year fixed effects	YES	YES	YES	YES	YES	YES
Country fixed effects	NO	NO	NO	NO	YES	NO
Adjusted R^2	0.321	0.381	0.360	0.367	0.356	0.416

Notes: The table reports the results of ordinary least squares regression for CAR[-20;+20] relative to the announcement date (t=0). The model is estimated with Huber-White corrected standard errors clustered by the issuing firm. The independent variables are: SIZE = logarithm of total assets; LEV = ratio of total assets to total liabilities; ROE = return on equity; PREPERF = one year buy and hold abnormal return before the issue announcement net of the same return computed for the market index; LOSSVOL = standard deviation of loss ratios (defined as claim and loss expenses plus long-term insurance reserves scaled by premium income) over a four-year period prior to the announcement date; FREQUENT = dummy variable which equals 1 if the issuer has issued 5 or more Cat bonds during the observation period (and 0 otherwise); ISSUESIZE = ratio of total risk capital issued to total shareholders' equity; INDEM = dummy variable which equals 1 if the Cat bond has an indemnity trigger (and 0 otherwise); BONDRATING = the bond rating applied by Standard &Poor's or Moody's with 1 being the highest rated bond and 18 being not rated; MORTALITY = dummy variable which equals 1 if the securitized risk is linked to mortality risk (and 0 otherwise); SOFTMARKET = dummy variable which equals 1 if the bond is issued during the lowest quintile for the Guy Carpenter Rate On Line Index (Source: Guy Carpenter, 2010). All accounting data (unless stated differently) refer to one fiscal year prior to the announcement of the Cat bond issue (t-1) and are from Worldscope. The t-statistics (two tailed) of the coefficients are reported in the parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.